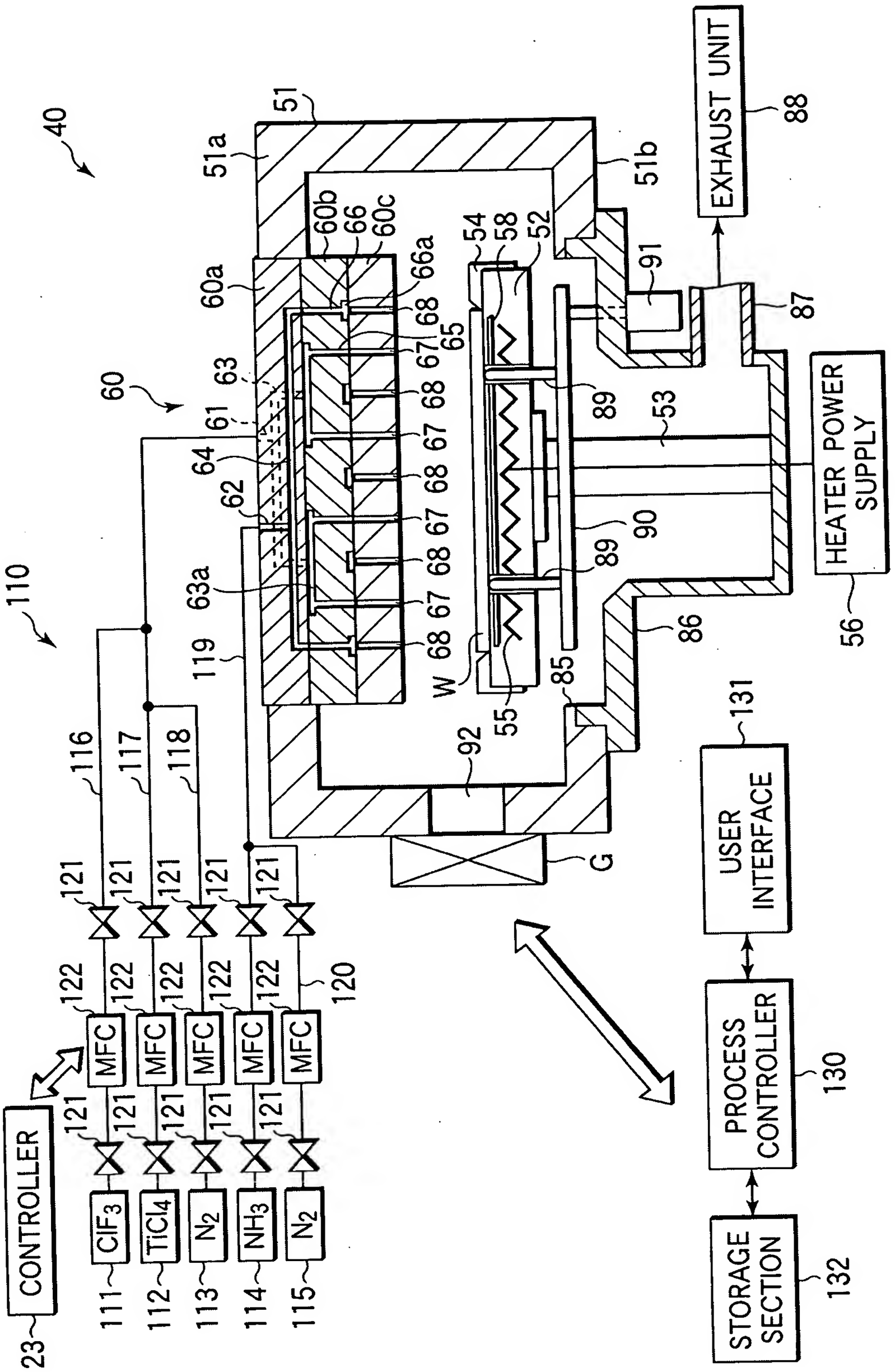
40
51
51a
51b
60
60a
60b
60c
66
66a
54
58
52
91
EXHAUST UNIT
88
87
89
53
HEATER POWER SUPPLY
56
90
86
85
55
92
W
G
63
61
64
62
63a
119
65
67
68
110
116
117
118
121
122
120
MFC
CONTROLLER
123
111
112
113
114
115
ClF_3
$TiCl_4$
N_2
NH_3
N_2
131
USER INTERFACE
PROCESS CONTROLLER
130
STORAGE SECTION
132

FIG.1

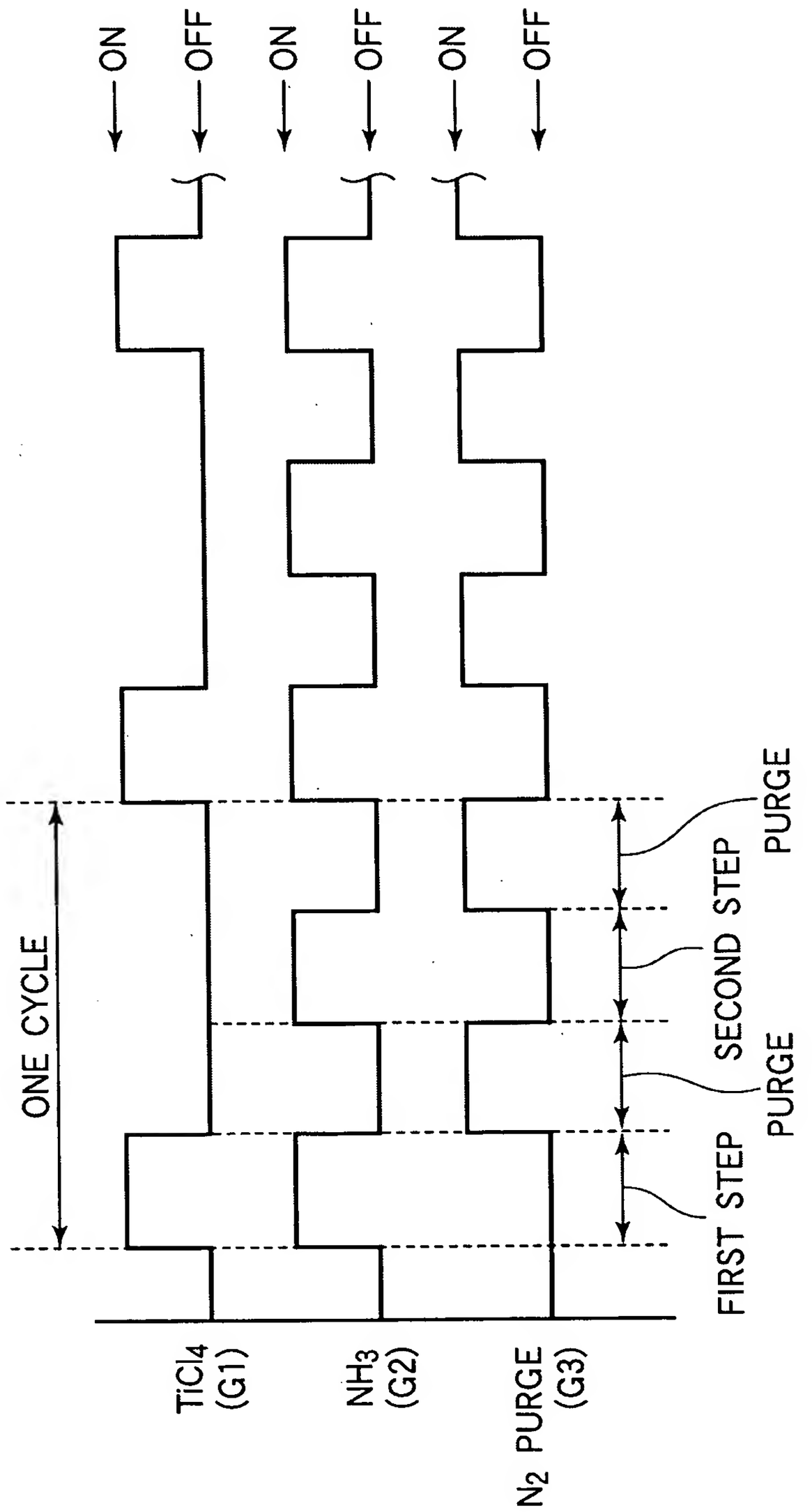
ON
OFF
ON
OFF
ON
OFF
ONE CYCLE
PURGE
SECOND STEP
PURGE
FIRST STEP
TiCl4 (G1)
NH3 (G2)
N2 PURGE (G3)

FIG.2

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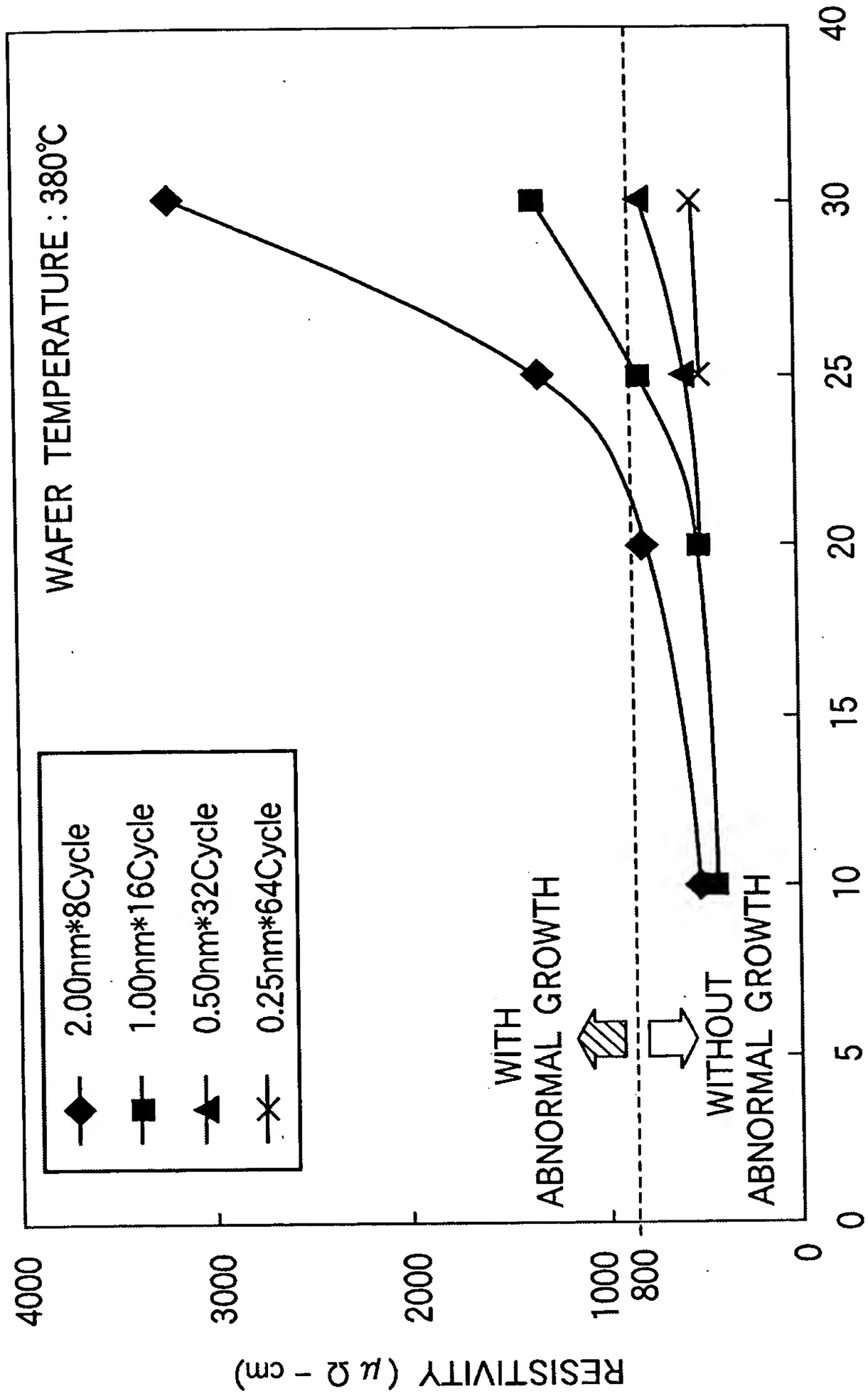
WAFER TEMPERATURE : 380°C
2.00nm*8Cycle
1.00nm*16Cycle
0.50nm*32Cycle
0.25nm*64Cycle
WITH ABNORMAL GROWTH
WITHOUT ABNORMAL GROWTH
RESISTIVITY (μΩ - cm)
NH3 PARTIAL PRESSURE (Pa)
4000
3000
2000
1000
800
0
0
5
10
15
20
25
30
40

FIG.3

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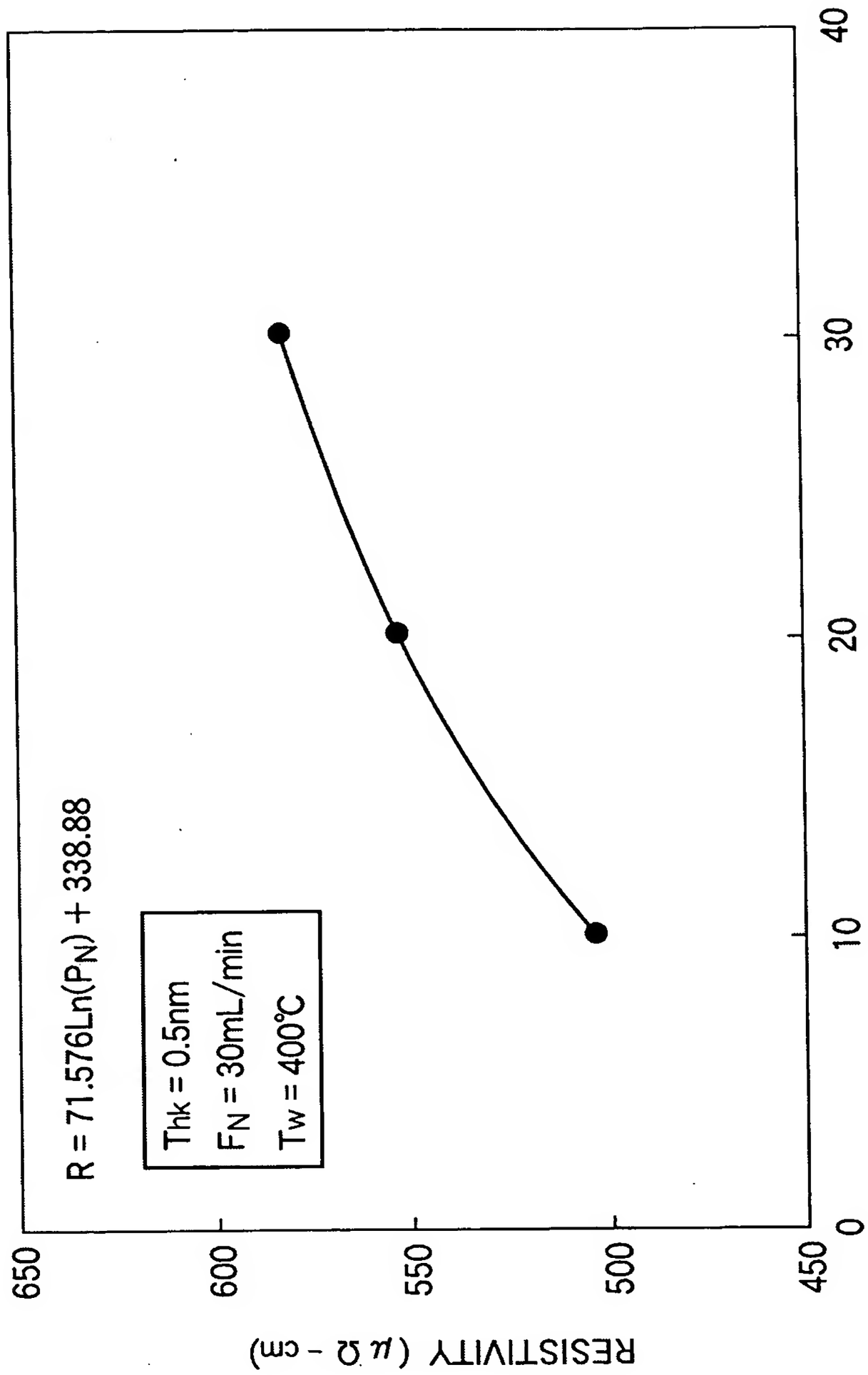
RESISTIVITY (μΩ - cm)
650
600
550
500
450
0
10
20
30
NH3 GAS PARTIAL PRESSURE PN (Pa)
40
R = 71.576Ln(PN) + 338.88
Thk = 0.5nm
FN = 30mL/min
Tw = 400°C

FIG.4

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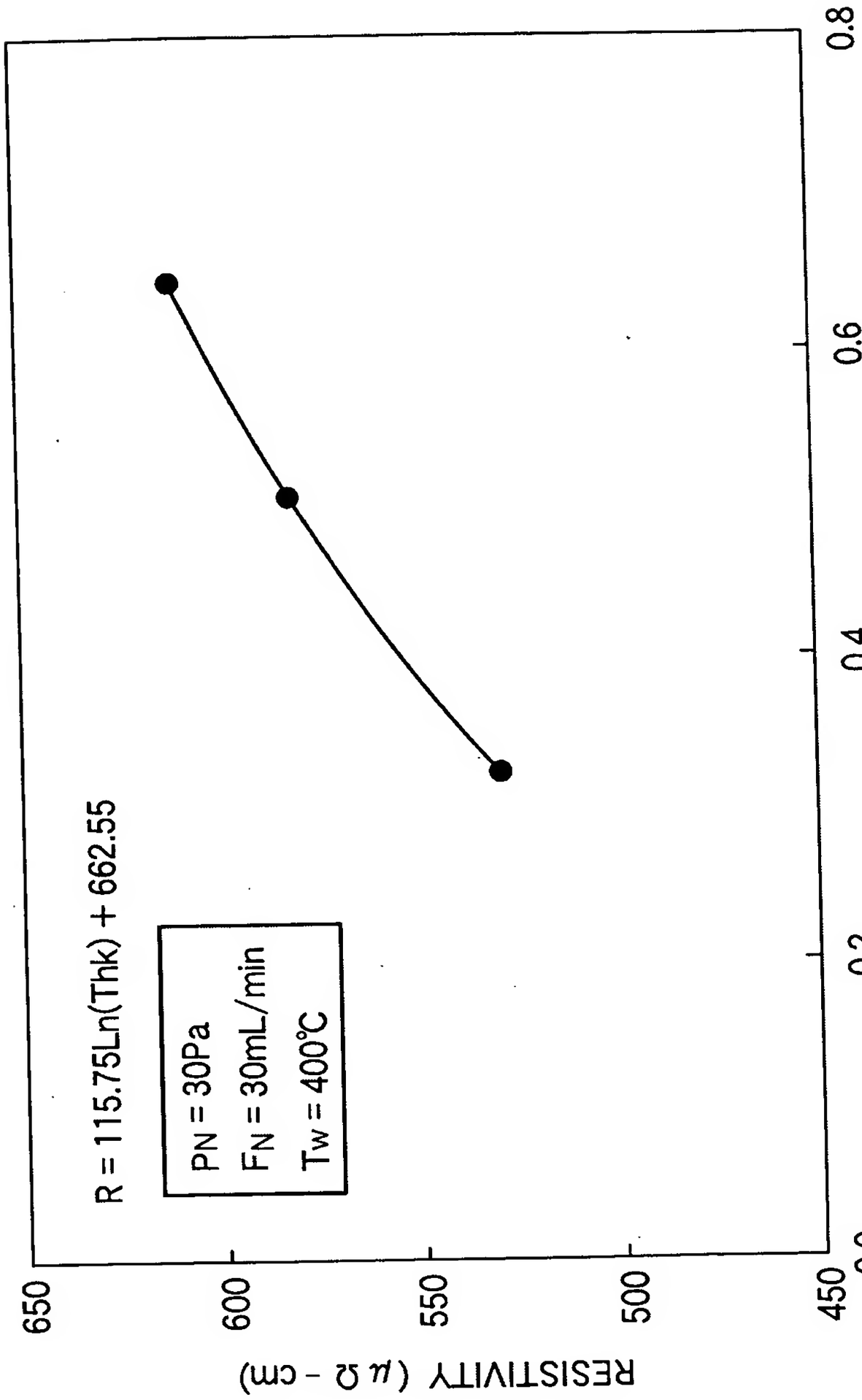
RESISTIVITY (μΩ - cm)
650
600
550
500
450
0.0
0.2
0.4
0.6
0.8
ONE-CYCLE FILM THICKNESS Thk (nm)
R = 115.75Ln(Thk) + 662.55
PN = 30Pa
FN = 30mL/min
Tw = 400°C

FIG.5

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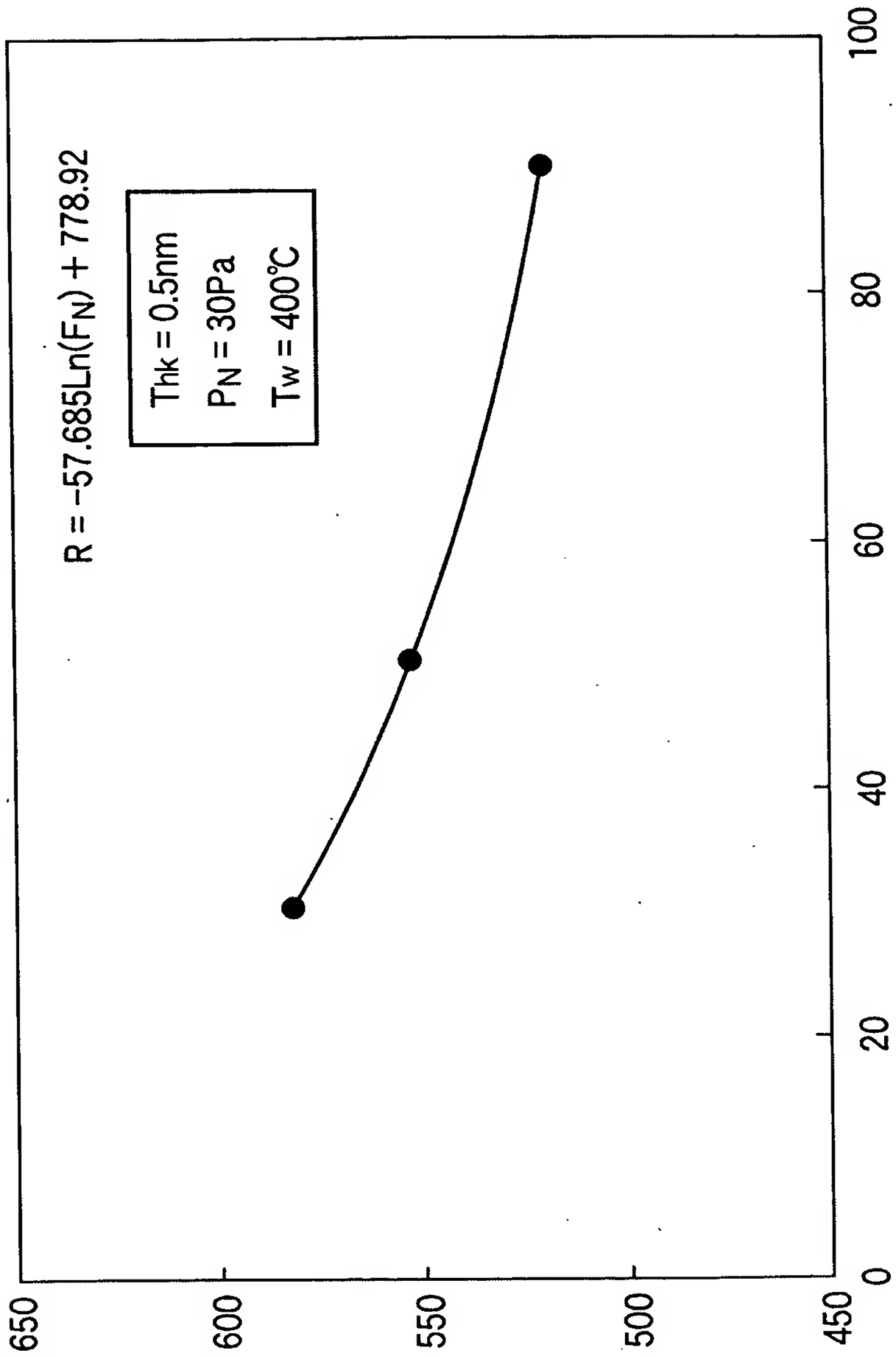
R = −57.685Ln(FN) + 778.92
Thk = 0.5nm
PN = 30Pa
Tw = 400℃
RESISTIVITY (μΩ − cm)
650
600
550
500
450
0
20
40
60
80
100
NH3 GAS FLOW RATE FN (mL/min)

FIG.6

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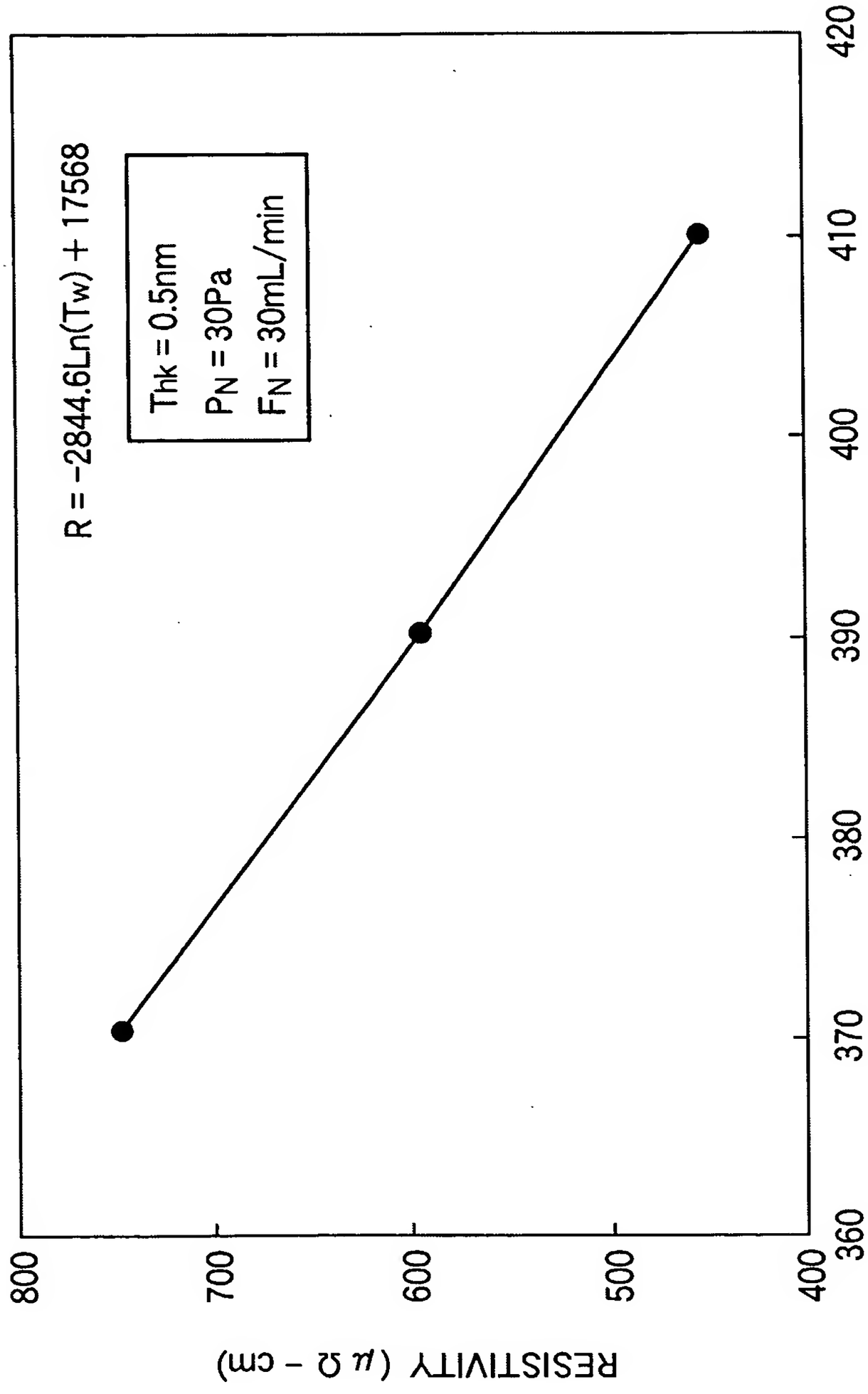
420
R = −2844.6Ln(Tw) + 17568
Thk = 0.5nm
PN = 30Pa
FN = 30mL/min
370
380
390
400
410
WAFER TEMPERATURE (°C)
800
700
600
500
400
360
RESISTIVITY (μΩ - cm)

FIG.7

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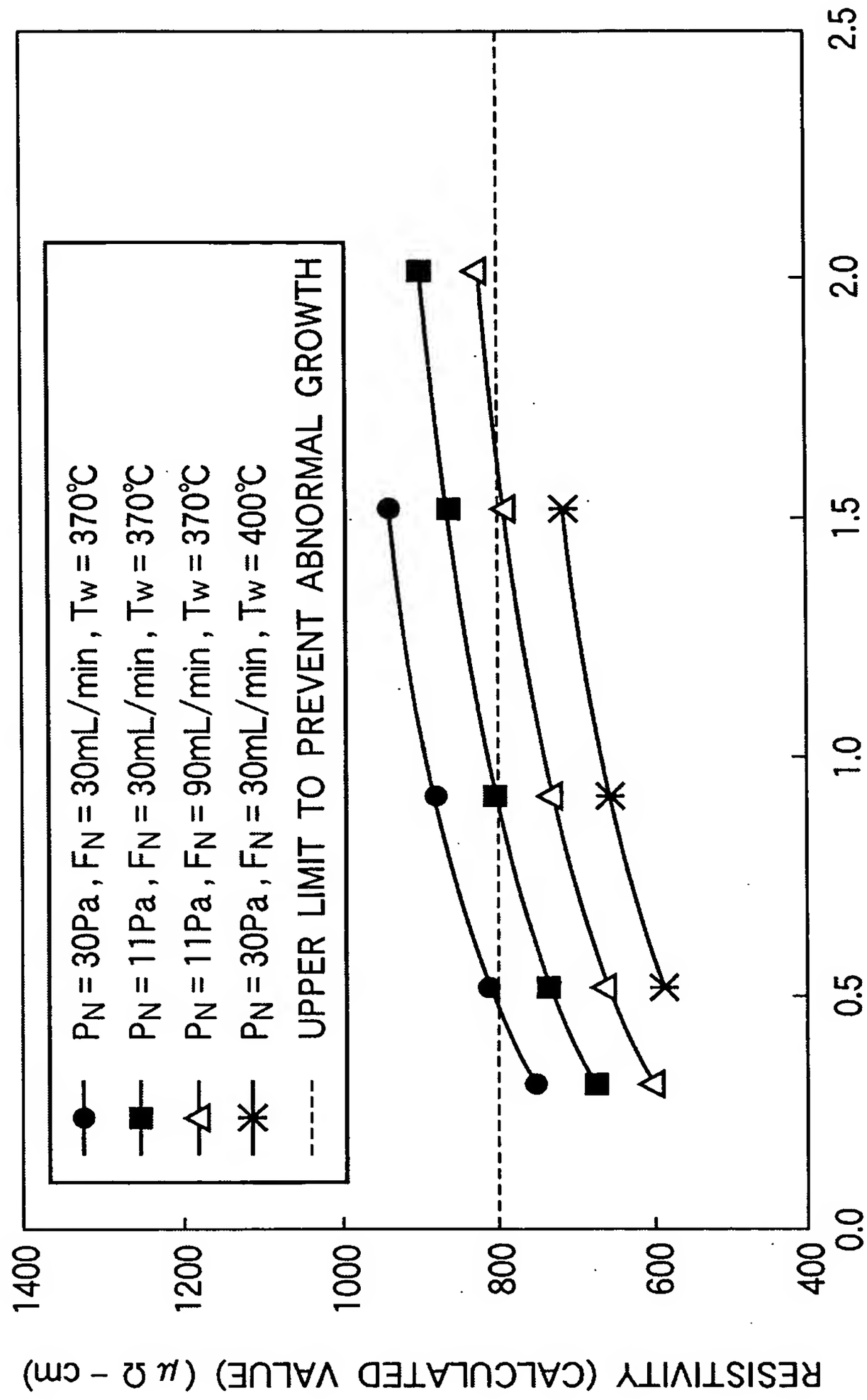
RESISTIVITY (CALCULATED VALUE) (μΩ – cm)
1400
1200
1000
800
600
400
0.0
0.5
1.0
1.5
2.0
2.5
ONE-CYCLE FILM THICKNESS Thk (nm)
PN = 30Pa, FN = 30mL/min, Tw = 370°C
PN = 11Pa, FN = 30mL/min, Tw = 370°C
PN = 11Pa, FN = 90mL/min, Tw = 370°C
PN = 30Pa, FN = 30mL/min, Tw = 400°C
UPPER LIMIT TO PREVENT ABNORMAL GROWTH

FIG.8

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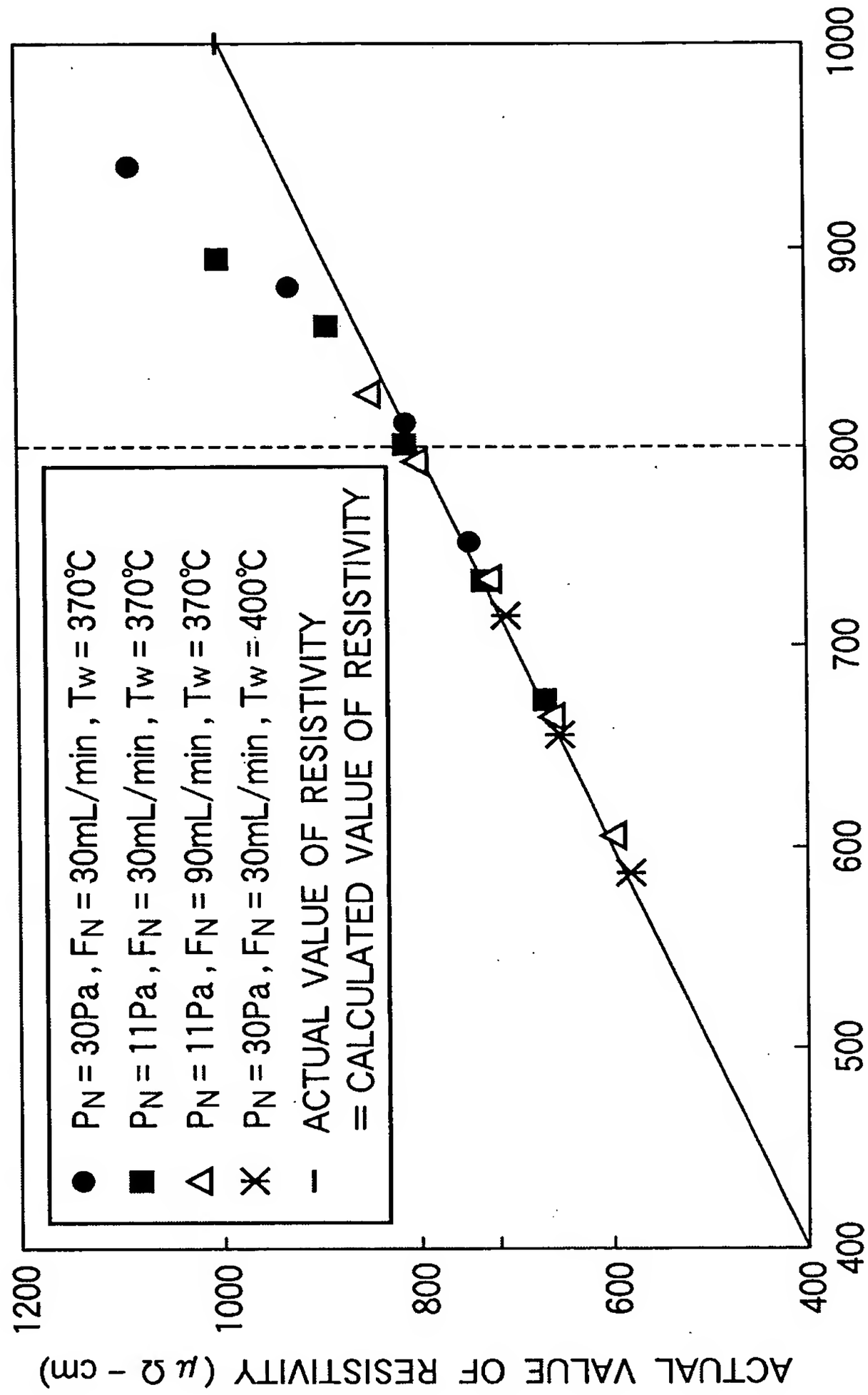
ACTUAL VALUE OF RESISTIVITY (μΩ - cm)
1200
1000
800
600
400
400
500
600
700
800
900
1000
CALCULATED VALUE OF RESISTIVITY (μΩ - cm)
● PN = 30Pa, FN = 30mL/min, Tw = 370℃
■ PN = 11Pa, FN = 30mL/min, Tw = 370℃
△ PN = 11Pa, FN = 90mL/min, Tw = 370℃
✳ PN = 30Pa, FN = 30mL/min, Tw = 400℃
— ACTUAL VALUE OF RESISTIVITY
= CALCULATED VALUE OF RESISTIVITY

FIG.9

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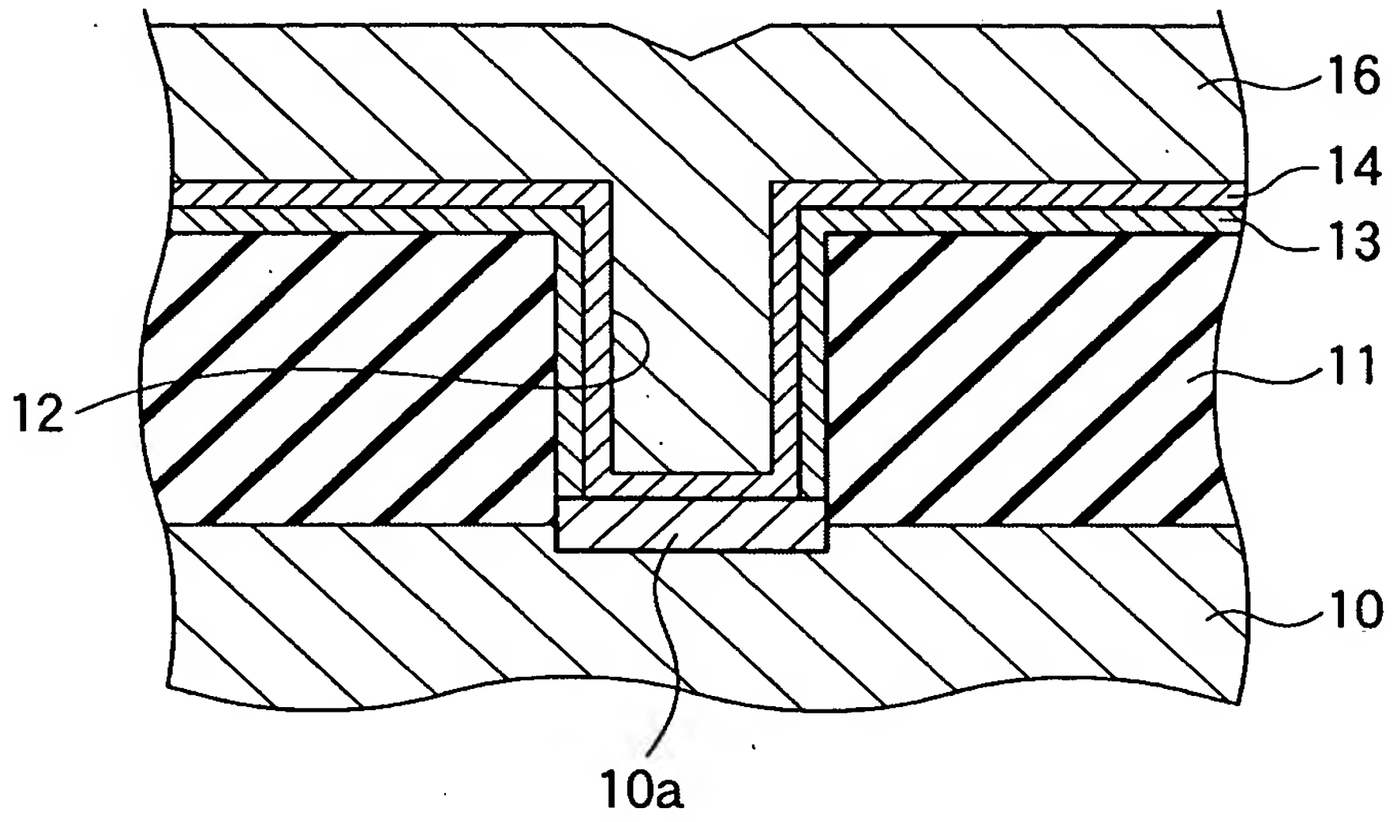

FIG.10

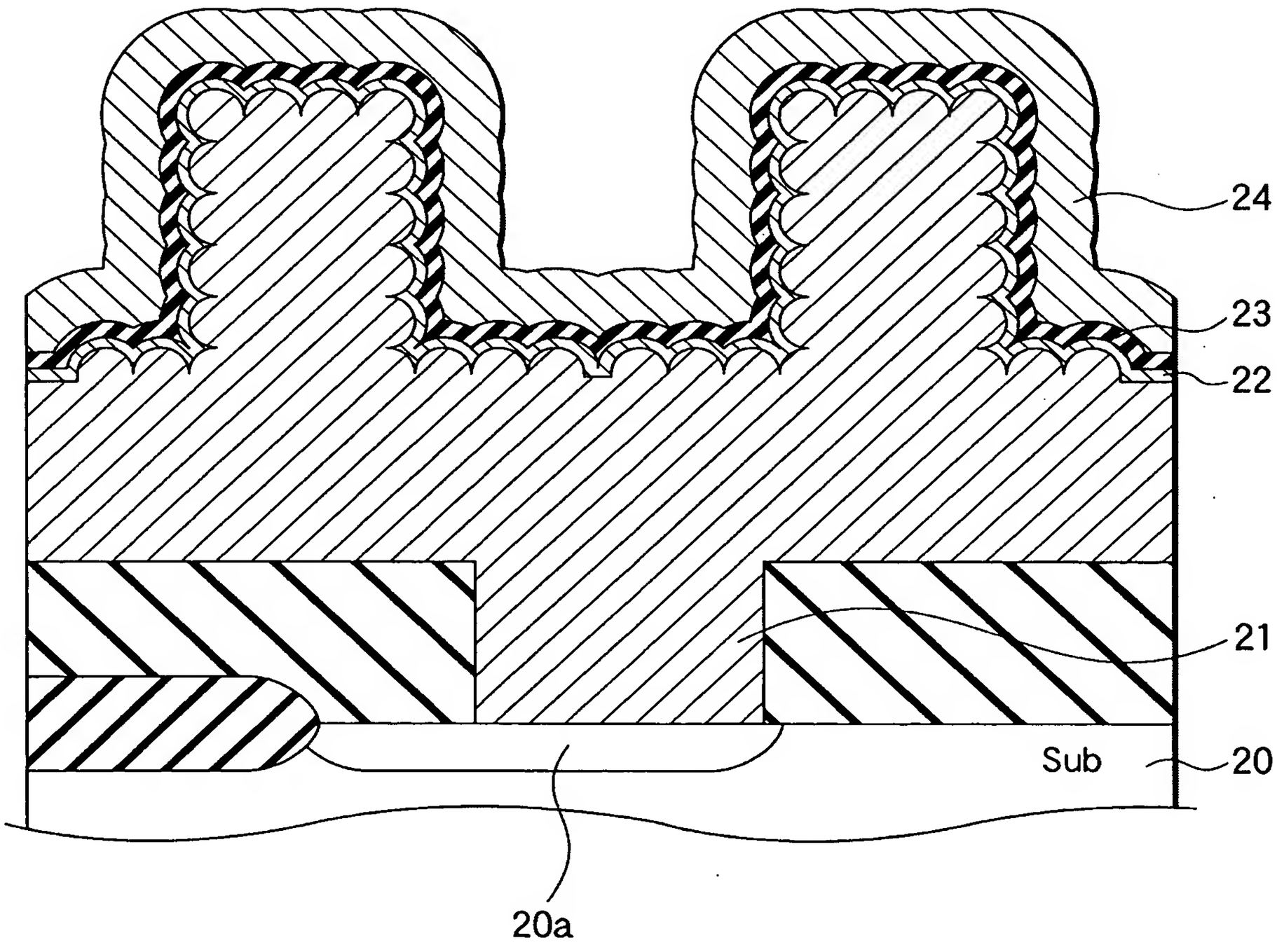

FIG.11

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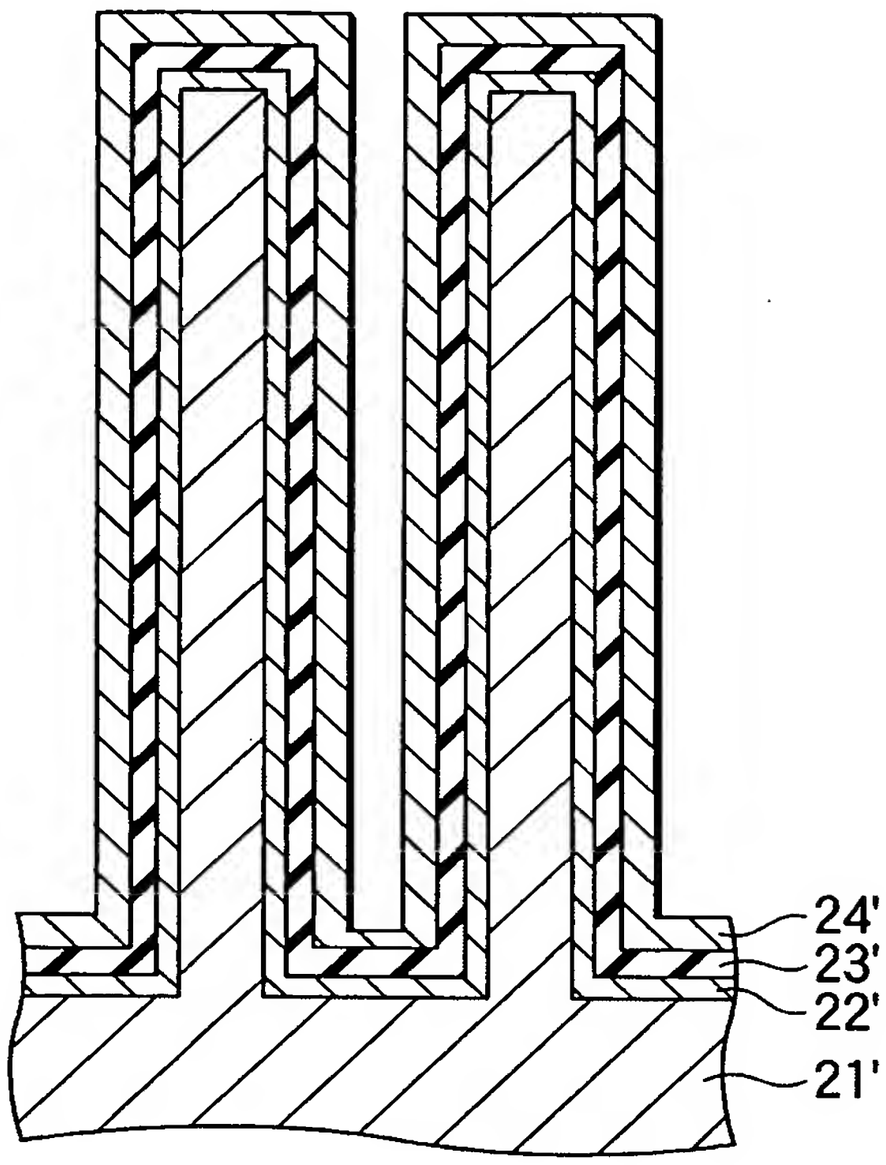

FIG.12

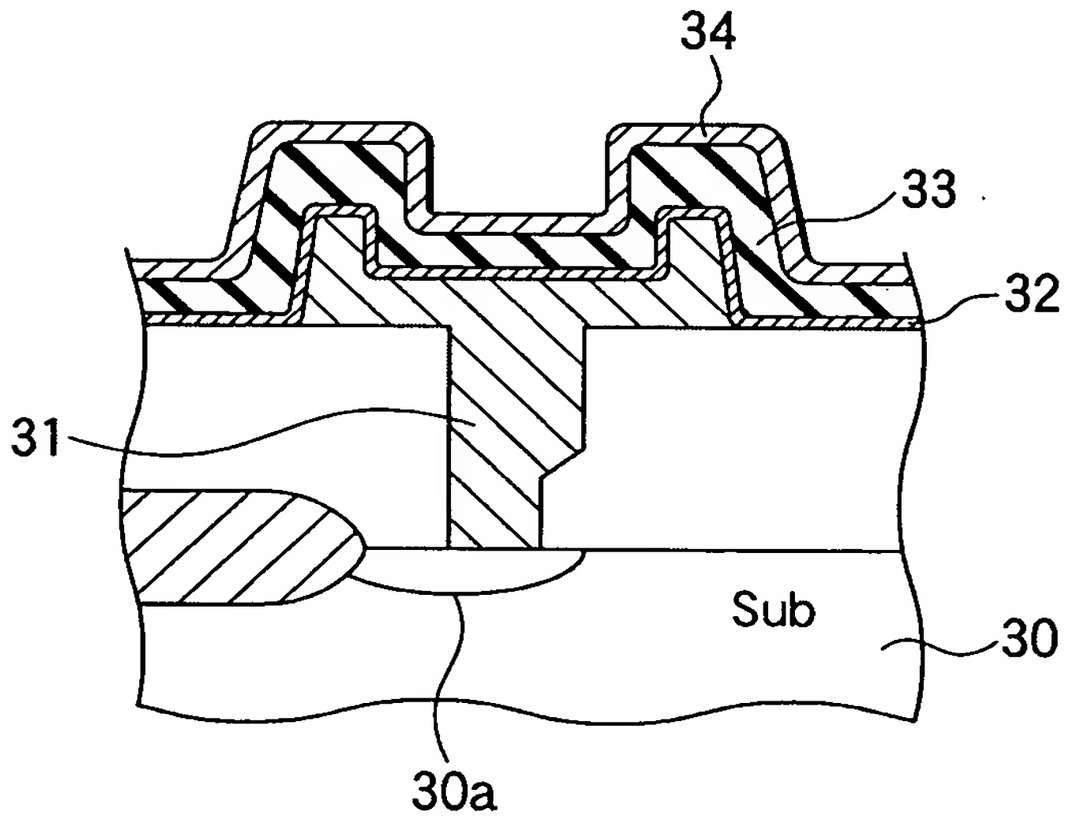

FIG.13